

Effect of Polypropylene Fibre on Stability of Expansive Soil

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Abstract : *Soil stabilization can be explained as the alteration of the soil properties by chemical or physical means in order to enhance the engineering quality of the soil. The process of soil stabilization helps to achieve the required properties in a soil needed for the construction work. Soil improvement could either be by modification or stabilization or both. Soil modification is the addition of a modifier (cement, lime etc.) to a soil to change its index properties, while soil stabilization is the treatment of soils to enable their strength and durability to be improved such that they become totally suitable for construction beyond their original classification. Expansive soils also known as swelling soils or shrink-swell soils are the terms applied to those soils, which have a tendency to swell and shrink with the variation in moisture content. As a result of which significant distress in the soil occurs, causing severe damage to the overlying structure. Soil possesses excellent performance at the optimum moisture content or below the optimum moisture content (dry side of optimum); however the strength and stiffness of soils reduces drastically as the moisture content increases beyond the optimum (wet side of optimum). This study is carried out with an intention to evaluate the effects of polypropylene fiber on the geotechnical properties of the locally available black cotton soil (Expansive soil) from Harihara city. Tests which are to be carried out on the sample of soil dealt with consistency limits, specific gravity, compaction, California bearing ratio, unconfined compressive strength and shear strength. These tests are to be conducted at both non-stabilized and stabilized states by adding 0%, 0.5%, 1%, 1.5%, 2%, 2.5%, 3% of polypropylene fibre. The results show the effect of polypropylene fibre on geotechnical properties of the soil samples strength.*

Keywords: Stabilization, polypropylene fibre (PPF), expansive soil, CBR, Unconfined.

I. Introduction

Expansive soils also known as swelling soils or shrink-swell soils are the terms applied to those soils, which have a tendency to swell and shrink with the variation in moisture content. Such tendency of soil is due to the presence of fine clay particles, Swell, when they come in contact with water, resulting in alternate swelling and shrinking of soil due to which differential settlement of structure takes place. As a result of which significant distress in the soil occurs, causing severe damage to the overlying structure.

During monsoon's, these soils absorb the water, swell, become soft and their capacity to bear water is reduced, while in drier seasons, these soils shrink and become harder due to evaporation of water. These types of soils are generally found in arid and semi-arid regions of the world and are considered as a

potential natural hazard, which if not treated well can cause damages to not only to the structures built upon them but also can cause loss of human life.

Black Cotton Soil are soils or soft bedrock that increases in volume or expand as they get wet and shrink as they dry out. In India this Expansive soil is called "Black Cotton Soil". Colour of this soil reddish brown to black and this helps for cultivation of cotton, so is called black cotton swelling soil covers about 30% of the land area in India. They are also commonly known as bentonite, expansive, or Black Cotton soil. In terms of geotechnical Engineering, Black Cotton soil is one which when associated with an engineering structure and in presence of water will show a tendency to swell or shrink causing the structure to experience moments which are largely unrelated to the direct effect of loading by the structure.

II. Material and Methodology

Black Cotton Soil: Black cotton soil which is expansive in nature was collected from Harihara Taluk, Davanagere District, and Karnataka.

Polypropylene fibre: Polypropylene fibre is the most widely used in the laboratory testing of soil reinforcement. Currently, PP fibres are used to enhance the soil strength properties, to reduce the shrinkage properties and to overcome chemical and biological degradation.

Methodology

Following laboratory tests have been carried out as per IS: 2720. The tests were carried out both on natural soil and stabilized soil with Lime and Quarry dust.

1. Differential Free Swell index – IS 2720 Part-XI, 1972.
2. Grain size analysis – IS 2720 Part 4, 1985
3. Specific gravity - IS 2720 Part-3, 1980
4. Liquid limit - IS 2720 Part-5, 1985
5. Proctor Compaction – IS 2720 Part-8, 1983
6. CBR test – IS 2720 Part-16, 1987
7. Unconfined compression – IS 2720 Part-10, 1991
8. Direct Shear test - IS: 2720 Part-13, 1986

Sampling of Soil

The laboratory studies were carried out on the samples of Soil, Soil + polypropylene fibre, for different percentage of Lime and Quarry dust as shown in the below proportion by weight of the soil. Soil Particulars

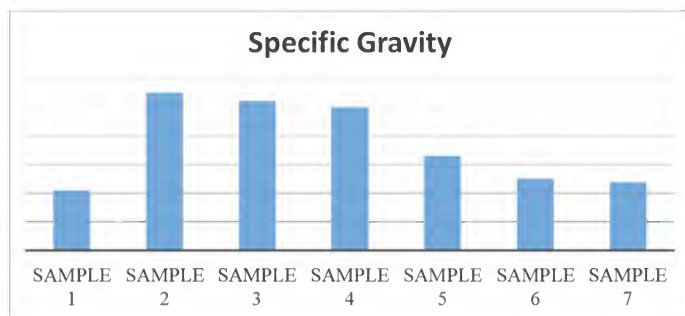
Sl No	Soil Sample	Composition of soil
01	Sample 1	100% Soil
02	Sample 2	99.5% soil +0.5% PPF
03	Sample 3	99.0% soil +1.0% PPF
04	Sample 4	98.5% soil +1.5% PPF
05	Sample 5	98.0% soil +2.0% PPF
06	Sample 6	97.5% soil +2.5% PPF
07	Sample 7	97.0% soil +3.0% PPF

III. Results and Tables

Following tables and graphs gives the overall results of Specific gravity, Liquid limit, Maximum dry density, Optimum moisture content, CBR, Unconfined compressive strength.

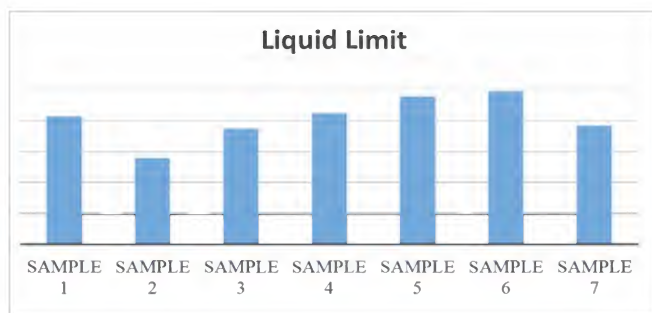
Table 1: at end

Following Graph 1 shows the variation of specific gravity for soil with reference mix of polypropylene fibre.



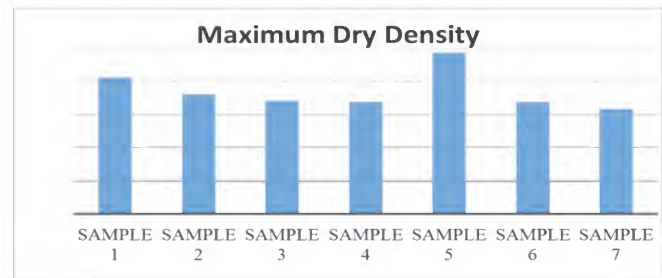
Graph 1: Variation of specific gravity

Following Graph 2 shows the variation of liquid limit for soil with reference mix of polypropylene fibre..



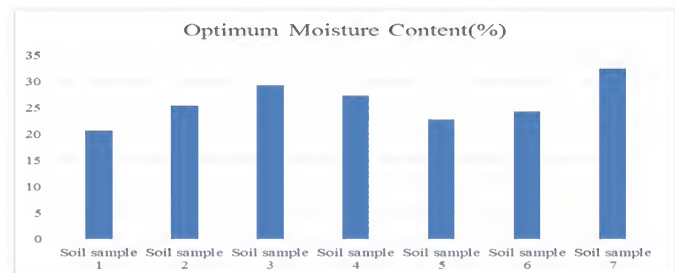
Graph 2: Variation of liquid limit

Following Graph 3 shows the variation of maximum dry density for soil with reference mix of polypropylene fibre..



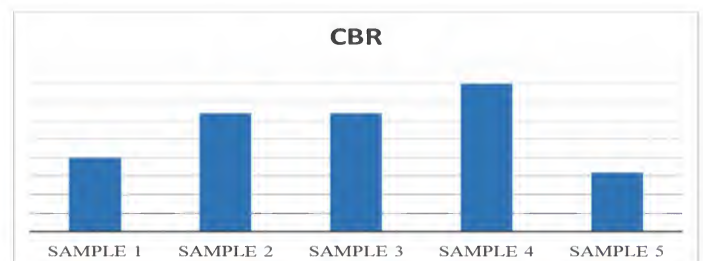
Graph 3: Variation of maximum dry density

Following Graph 4 shows the variation of optimum moisture content for soil with reference mix of polypropylene fibre..



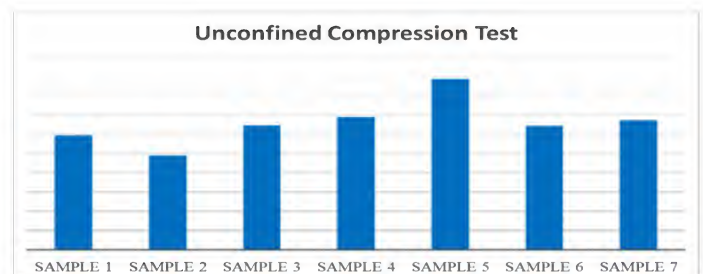
Graph 4: Variation of optimum moisture content

Following Graph 5 shows the variation of CBR value for soil with reference mix of polypropylene fibre..



Graph 5: Variation of CBR value

Following Graph 6 shows the variation of unconfined compressive strength for soil with reference mix of polypropylene fibre..



Graph 6: Variation of unconfined compressive strength

IV. Conclusions

1. Specific gravity of BC soil decreased with the addition of polypropylene fibre.
 2. Maximum dry density (MDD) is observed at soil sample 5 for addition of polypropylene fibre. Further addition of it, MDD value decreased. By this it indicates that the, optimum value would be soil sample 5.
 3. Shear parameters such as cohesion, C decreased and angle of shearing resistance, ϕ increased at soil sample 5 compared to natural soil.
 4. The Maximum CBR value is 4.00% which is achieved by soil sample 4.
 5. The maximum compression test value is 8.88 Kg/cm^2 which is achieved by soil sample 5.
- So, from our project soil sample 4 and soil sample 5 will give the better Engineering properties on the addition of admixture.

References

- i. Abhinav Nangia, Sudhir Nigam, Dharmendra Kumar, Shailendra Tiwari, "Effect of Polypropylene Fibre on the Strength Characteristics of the Soils along the Yamuna River Bank in Delhi City".
- ii. Ayyappan S., Hemalatha K. and Sundaram M., June [2010], "Investigation of Engineering Behavior of Soil, Polypropylene Fibers and Fly Ash -Mixtures for Road Construction".
- iii. Bowles J.E., 1996, "Foundation Analysis and Design", 5th Edition, McGraw Hill Pub. Co. New York.
- iv. Mona Malekzadeh, Huriye Bilsel, 2012, "Effect of Polypropylene Fiber on Mechanical Behaviour of Expansive Soils".
- v. Phani Kumar. V, Naga Bharath C.H., Ganga D., Swathi Priyadarsini P., January 2015, "Experimental Investigation on California Bearing Ratio (CBR) For Stabilizing Silty Sand with Fly Ash and Waste Polypropylene".

vi. Punmia B.C., Ashok Kumar Jain, Arun Kumar Jain, "Soil Mechanics and Foundations", Laxmi Publication (P) LTD. 16th Edition, 1980.

vii. Sachin N. Bhavsar, Ankit J. Patel, "Effect of waste material on swelling and shrinkage properties of clayey soil".

viii. Twinkle S., Sayida M.K., December 2011, "Effect of polypropylene fibre and lime admixture on engineering properties of expansive soil".

IS Codes:

i. IS: 2720 (Part 3) (1980). Methods of Test for Soils: Determination of Specific Gravity, Bureau of Indian Standards, New Delhi, India

ii. IS: 2720 (Part 4) (1985). Methods of Test for Soils: Determination of Grain Size Analysis, Bureau of Indian Standards, New Delhi, India

iii. IS: 2720 (Part 5) (1985). Methods of Test for Soils: Determination of Liquid and Plastic Limit, Bureau of Indian Standards, New Delhi, India.

iv. IS: 2720 (Part 40) (1977). Methods of Test for Soils: Determination of Free Swell Index of Soils, Bureau of Indian Standards, New Delhi, India

v. IS: 2720 (Part 7) (1980). Methods of Test for Soils: Determination of Water Content-Dry Density Relation Using Light Compaction, Bureau of Indian Standards, New Delhi, India

vi. IS: 2720 (Part 16) (1987). Methods of Test for Soils: Determination of CBR Value, Bureau of Indian Standards, New Delhi, India

vii. IS: 2720 (Part 3) (1980). Methods of Test for Soils: Determination of Unconfined Compression Strength, Bureau of Indian Standards, New Delhi, India.

Table 1: Overall results of Experiments.

Description	sample 1	sample 2	sample 3	sample 4	sample 5	sample 6	sample 7
Grain size analysis	$C_u = 14.16$ $C_c = 2.75$	-	-	-	-	-	-
Specific gravity	2.01	2.35	2.32	2.30	2.13	2.05	2.04
Swell index (%)	50.0	-	-	-	-	-	-
Liquid limit (%)	41.50	29.00	37.00	41.50	48.00	49.50	38.50
Plasticity Index (%)	20.57	19.48	23.67	16.50	8.00	21.38	11.36
Optimum Moisture Content (%)	20.65	25.45	29.21	27.28	22.77	24.25	32.40
Maximum Dry Density (g/cc)	2.06	1.805	1.71	1.69	2.43	1.69	1.58
CBR (%)	2	3	3	4	2	-	-
Unconfined Compressive Strength (Kg/cm ²)	5.94	4.89	6.45	6.9	8.88	6.44	6.72